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Diagnosis of gender gaps in higher education: a case study in the civil construction program at Federico Santa María Technical University

Diagnóstico de brechas de género en la educación superior: un estudio de caso en el programa de construcción civil de la Universidad Técnica Federico Santa María

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Abstract

The low participation of women in the construction industry in Chile highlights persistent gender gaps, shaped by stereotypes and prejudices regarding women's skills. This study explores the gaps and challenges faced by female civil construction students at the Federico Santa María Technical University, addressing an existing knowledge gap. A systematic review following the PRISMA methodology was conducted, analyzing eight relevant articles. This was complemented by a qualitative survey applied to 47 female civil construction students and ten semi-structured interviews with key female students. The findings reveal that cultural stigma, and the lack of female role models are significant barriers to women's involvement in construction. Nevertheless, factors such as family support, personal interest, and the presence of female professors positively influence their decision to pursue and remain in the field. Despite experiencing harassment, many women feeling supported in their professional environment. This study provides an evidence-based understanding of these disparities and suggests targeted action to foster greater inclusion of women in the industry. Future research should examine the impact of female role models on the recruitment and retention of women in construction careers and develop educational and institutional strategies to close these gender gaps.

Keywords: Women in construction; Construction students; Gender gaps; Construction industry in Chile; Civil construction.

Resumen

La baja participación de las mujeres en la industria de la construcción en Chile pone de manifiesto la persistencia de brechas de género, influenciadas por estereotipos y prejuicios sobre las habilidades de las mujeres. Este estudio explora las brechas y desafíos que enfrentan las estudiantes de construcción civil de la Universidad Técnica Federico Santa María, abordando así la brecha existente en el conocimiento. Se realizó una revisión sistemática siguiendo la metodología PRISMA, analizando ocho artículos relevantes. Esto se complementó con una encuesta cualitativa aplicada a 47 estudiantes mujeres de construcción civil y diez entrevistas semiestructuradas a estudiantes clave. Los resultados revelan que el estigma cultural y la falta de modelos femeninos son barreras significativas para la participación de mujeres en la construcción. No obstante, factores como el apoyo familiar, el interés personal y la presencia de profesoras influyen positivamente en su decisión de ingresar a este campo y permanecer en él. A pesar de sufrir acoso, muchas mujeres se sienten respaldadas en su entorno profesional. Este estudio proporciona una comprensión basada en pruebas de estas disparidades y sugiere medidas específicas para fomentar una mayor inclusión de las mujeres en el sector. Las investigaciones futuras deberían examinar el impacto de los modelos femeninos en la contratación y la permanencia de las mujeres en carreras de construcción y desarrollar estrategias educativas e institucionales para mitigar estas brechas de género.

Palabras clave: Mujeres en la construcción; Estudiantes de construcción; Brechas de género; Industria de construcción Chile; Construcción civil.

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1. Introduction

Historically, the construction industry has been perceived as a predominantly male sector (Lekchiri and Kamm, 2020), reflected in its low female participation. In Chile, women represent only 8.5% of the workforce in the sector (CChC, 2022), a figure that mirrors the global reality. This landscape presents significant challenges for integrating new female workers and their long-term retention. Among the most frequently mentioned obstacles in the literature are the lack of promotion opportunities, wage inequality, harassment, and biases regarding women's capabilities (Heydari et al., 2024); (Yan et al., 2024); (Lekchiri and Kamm, 2020). Several studies suggest that one of the most effective ways to encourage female participation in construction is through support from the university stage (Zhang et al., 2021); (Menches and Abraham, 2007). This underscores the importance of working through education to close gender gaps in this industry.

In higher education, women's participation in STEM (Science, Technology, Engineering, and Mathematics) has been a growing topic of interest and analysis in recent decades. Globally, the underrepresentation of women in these fields has raised concerns, especially in pursuing gender equality (Canales et al., 2022). Studies on female participation in STEM areas highlight the existence of structural and cultural barriers that perpetuate gender inequity. The National Academies of Sciences, (2018) notes that harassment in male-dominated environments is an alarming phenomenon exacerbated by power concentration and organizational tolerance of inappropriate behavior. Similarly, a study by Conicyt (Berlien et al., 2016) reveals that gender biases in scientific careers impose "masculine" standards that exclude women, perpetuating a culture that historically diminishes their contributions.

In Chile, the analysis of first-year enrollment in STEM programs for 2023 shows a significant gender disparity favoring men, with an average of approximately 61% SiEs, (2024), highlighting how gender stereotypes limit women's perceptions of their ability to succeed in STEM areas (Del Rio et al., 2016); (Brantt et al., 2024). Specifically, the civil construction program recorded 2,371 enrolled students, of whom 568 were women and 1,803 were men (Mi Futuro, 2023).

Despite these obstacles, various initiatives have been implemented to encourage the entry and retention of women in STEM careers. In 2024, female representation in these fields reached 30.2%, thanks to programs such as More Women Scientists (+MC), which promote access and inclusion of women in these disciplines (DEMRE, 2024).

Therefore, this research aims to understand the gaps and challenges female civil construction students face at the Federico Santa María Technical University (USM) to provide information that can establish strategies to be implemented in higher education institutions to support students in their transition to professional careers. Ultimately, this seeks to contribute to their long-term retention in the sector.

2. State of the art

Traditionally, construction has been perceived as male-dominated (Lekchiri and Kamm, 2020). However, the increasing participation of women challenges this premise and presents new challenges (Yan et al., 2024). The authors focused the literature review on three fundamental topics: gender gaps in the construction industry at an international level, the participation of female students in this field, and the factors influencing the choice of a career in construction.

3. Female participation in construction at a global level

The discussion regarding the low participation of women in the construction sector has emerged recently. The literature analysis reveals a growing concern about this issue, with various studies identifying indicators that highlight global disparities (Heydari et al., 2024); (Afolabi and Akinola, 2021); (Lekchiri and Kamm, 2020). For example, in Spain, women represent only 8.9% of the workforce in this sector, and most are aged between 35 and 54 (Infante-Perea et al., 2021). Similarly, in the United States, women make up approximately 10% of construction professionals (Hamlet et al., 2021). Despite labor shortages in Australia, only 12% of the workforce in this sector is female (Carnemolla and Galea, 2021). In New Zealand, female representation is somewhat higher, reaching 15.8% of the workers in the industry Ministry of Business, Innovation and Employment, (2023). Elsewhere, women's participation is even scarcer: in South Africa, 6% of employment in this sector is reported to be female (Alves and English, 2018). In Nigeria, female participation is minimal and marked by persistent discrimination, limiting professional opportunities for women in this field (Afolabi and Akinola, 2021). Finally, in Chile, the presence of women in construction needs to be higher, representing only 11.50% of workers in 2023 (Ministerio de Economía, Fomento y Turismo, 2023), reflecting a challenge similar to that of other countries.

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4. Women in STEM careers related to the field of construction.

According to Alves and English, (2018), higher education institutions still need to adequately address the preparation of female students for a predominantly male industry. On the other hand, Owolabi, (2023) mentions that women face difficulties in advancing their professional careers in a sexist environment, from recruitment and selection to retirement (Owolabi et al., 2023). Historically, women have dropped out of engineering at higher rates than men (Hamlet et al., 2021), highlighting the importance of educational trajectories and the multiple factors influencing them. Despite demonstrated technical skills, the need for identification with the engineering and construction field may motivate women to leave it (Godwin and Potvin, 2017); (Hamlet et al., 2021). Furthermore, women often need clarification on whether their inclusion in the workplace is merely symbolic or necessary (Alves and English, 2018). This uncertainty makes them doubt whether their professional contributions are valued for their true quality and merit (Alves and English, 2018). Consequently, female students feel compelled to match or surpass their male peers to be valued and respected in the workplace (Alves and English, 2018). Additionally, they are forced to adapt to an already established environment and organization, in the best-case scenario, to be "included" in such spaces (Heydari et al., 2024).

5. Factors influencing the decision to choose a career in construction

The construction industry has traditionally been linked to masculine stereotypes, characterized by a perception that associates it with strenuous physical work, long hours, and reliance on brute strength (Yan et al., 2024); (Heydari et al., 2024); (Cao et al., 2020). This contributes to the view of a sector incompatible with women and family reconciliation (Ghanbaripour et al., 2023). This becomes evident in secondary education, where the need for proper guidance makes it difficult for construction to be seen as a valid and attractive option for academic training or professional development (Heydari et al., 2024). The dissemination of a distorted sector image by family members, teachers, and counselors reflects a lack of knowledge and cultural stigmas about these professions (Barreto et al., 2017). This widespread perception represents one of the first barriers to recruiting women into university programs related to construction (Heydari et al., 2024). According to the literature, sexism, fear of being disrespected, and doubts about achieving a successful career are some obstacles that lead female high school students to abandon the idea of choosing careers in this field (Zhang et al., 2021).

During their academic training, the lack of female role models exacerbates this situation due to the male predominance in teaching roles (Moraba and Babatunde, 2020). The absence of female role models and the lack of acceptance in non-traditional jobs for women reinforces integration barriers (Madikizela and Haupt, 2010); (Alves and English, 2018). The participation of female professors is critical to increasing student enrollment and improving retention and academic productivity (Keku, 2021); (Olushola and Akinola, 2021). However, gender inequality in academic positions, driven by factors such as discrimination, adverse working conditions, and negative perceptions, continues to limit the access of female graduates to these positions (Owolabi et al., 2023).

Finally, upon entering the labor market, women face additional challenges. The sector's culture penalizes those who require flexibility or part-time hours, mainly due to family responsibilities (Heydari et al., 2024); (MacDonald and Durdyev, 2021); (Lekchiri and Kamm, 2020). Gender stereotypes and the sexist allocation of positions limit promotion opportunities. At the same time, long hours, frequent relocations, harassment, lack of respect, wage discrimination, and informal recruitment processes reinforce the perception of an unwelcoming industry for women (Heydari et al., 2024); (Carnemolla and Galea, 2021); (Lekchiri and Kamm, 2020).

6. Proposals to foster female participation in the construction industry

Various studies have proposed solutions to encourage women's participation in construction-related fields by addressing the gender barriers in the sector. Alves and English, (2018) suggest that universities prepare graduates to participate on equal terms in the workplace, which includes integrating strategies for dealing with gender-based violence into the curricula. In turn, Hamlet et al., (2021) propose allocating resources to a contextualized curriculum that strengthens the identity of women pursuing engineering degrees to support their retention and success.
Other studies, such as those by Keku et al., (2021), underscore the importance of adopting inclusive and diverse approaches in construction professions to prevent gender exclusion. Carnemolla and Galea, (2021) Call on construction organizations and governments to implement cultural reforms that reduce gender gaps, improve working conditions, combat sexism, and promote workplace safety. They also suggest implementing quotas for female participation in tenders and regularizing informal hiring practices, which are barriers for women (Carnemolla and Galea, 2021).

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Additionally, the research by Owolabi et al., (2023) emphasizes the need to hire female professors in graduate programs as role models, which would attract and retain more women, thus increasing enrollment and graduation rates.

Finally, Carnemolla and Galea, (2021) highlight the necessity of conducting campaigns that transform the construction industry's image, focusing on changing masculinized work practices and enhancing support for women entering the sector. According to Carnemolla and Galea, 2021), these campaigns should target secondary school students, as well as their parents and teachers, since they are key figures in the choice of professional careers.

7. Methodology

This section describes the procedures used to address the research objectives. The methodological process was developed in three stages: first, the researchers conducted a systematic literature review in the Scopus database, guided by the PRISMA model, to identify previous studies on gender in the field of construction. In the second phase, the research team applied a survey of female civil construction students at the Universidad Técnica Federico Santa María, intending to examine the main gender gaps they face in their academic training. Finally, in the third phase, the researchers conducted semi-structured interviews with a selected sample of female students to delve deeper into the themes identified in the survey; these responses were analyzed through live coding to identify relevant patterns in their experiences. See Figure 1.

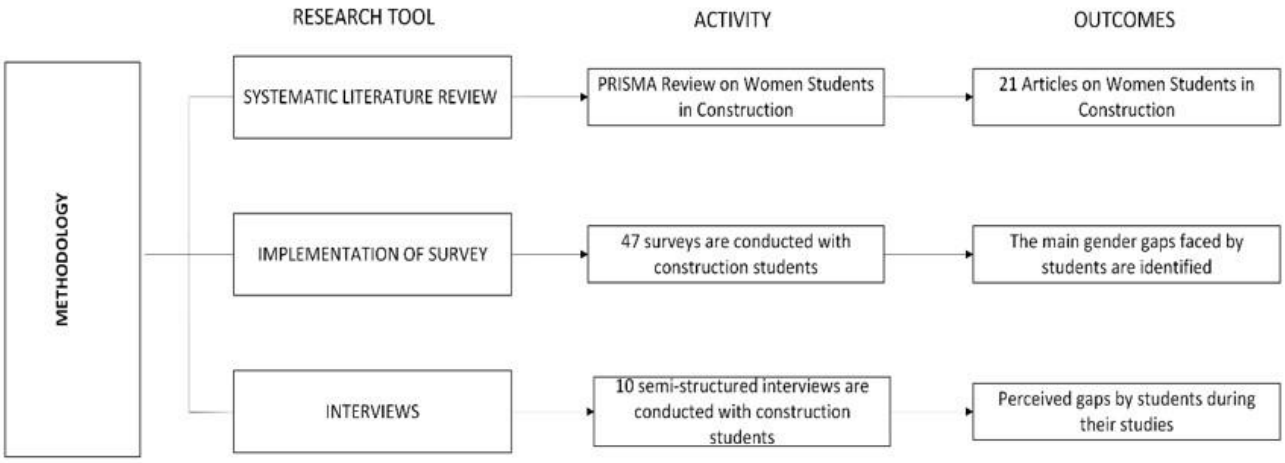

Figure 1. Methodology diagram

8. Systematic literature review

The first phase of this research was a systematic literature review. The research team selected the Scopus database for its ability to centralize information efficiently. Additionally, Scopus indexes only peer-reviewed sources, ensuring the data meets rigorous quality standards (De Granda et al., 2013).

Figure 1 illustrates a flowchart following the PRISMA 2020 model (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) (Page et al., 2021). This facilitates both the planning and execution of the systematic review. For the selection of sources, the researchers established criteria to include only results obtained from the Scopus database, using the keywords: “construction,” “women,” and “students.” Excluded documents were those that did not correspond to scientific articles, were not in Spanish or English, did not belong to the field of engineering, or were published before 2018. Initially, the researchers identified 1,009 documents in Scopus, from which they selected 21 articles after applying the abovementioned filters. Subsequently, the researchers removed those that were not relevant to the study or did not have free public access. See Figure 2.

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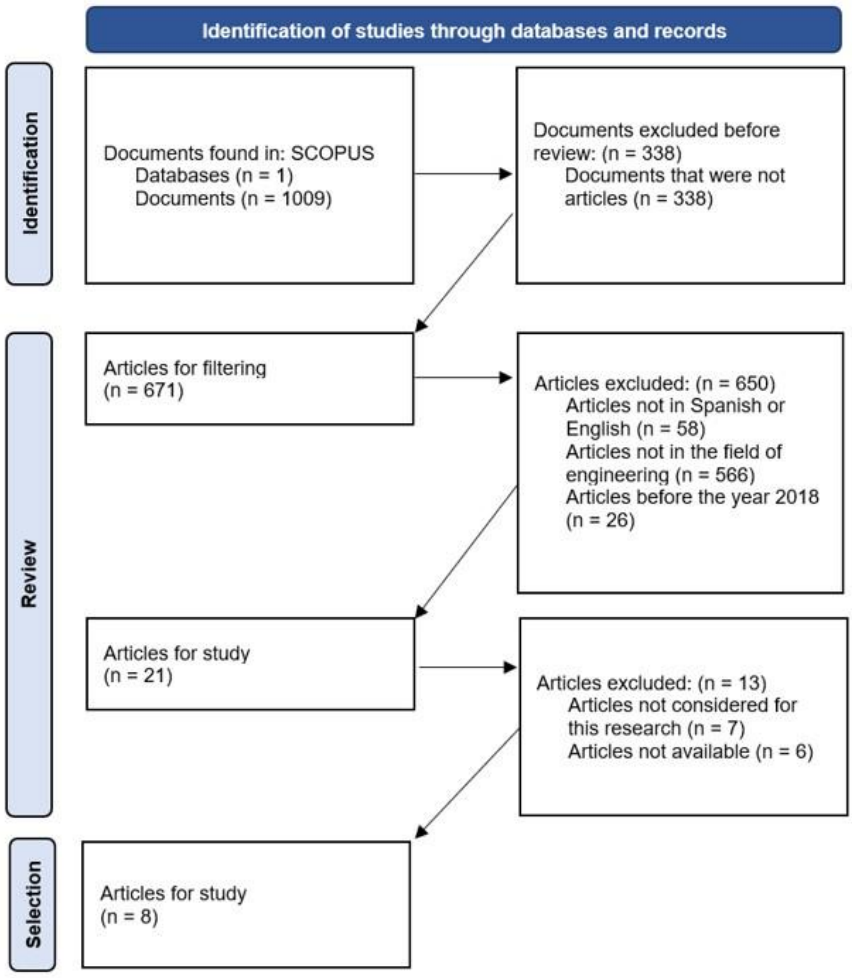

Figure 2. PRISMA 2020 Diagram.

9. Implementation of survey

The second part of this research consisted of a face-to-face survey of female civil construction students at the USM. A total of 47 female students participated, ranging from first-year students to those in their thesis stage, representing 90% of the female population in the program.

This survey aimed to identify the primary gender gaps experienced by students. Participation in the study was voluntary, and all collected information was kept confidential and anonymous, with no use beyond this research.
The questionnaire consisted of five questions, four closed-ended "yes" or "no" responses, and the last was an open-ended question. The questions asked were as follows:

- Do you feel your peers value your opinion the same as men?
- Have you considered changing your major due to cultural stigma?
- Have you experienced harassment during your academic life/university career?
- Are you aware of the steps to take in the event of harassment at the university?
- What concerns do you have about your professional future?

The results of the first four questions are displayed in the results section in Figure 2. For the last question regarding their future concerns, the researchers conducted a categorical analysis focused on the most recurring and significant themes: recognition of knowledge, career advancement, inappropriate situations, salary inequality, motherhood, and self-confidence.

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10. Conducting and analyzing interviews

Following the implementation and analysis of the surveys, the researchers conducted and analyzed ten semi-structured interviews with selected female students from the civil construction program at the USM, chosen through convenience sampling (Stratton, 2021).

11. Data collection

The data for this section was collected between July and September 2024. This exploratory study aims to delve deeper into the results obtained from the survey, which was answered by 90% of the female population in the program. The interviews provided a more detailed understanding of the perceptions and experiences of the female students regarding gender challenges in the program.

The interview structure focused on identifying the gender gaps present in the program. Additionally, they aimed to explore the motivations and difficulties female students face when choosing this career, considering the specific context of USM. Examples of the questions asked included:

- Why do you think more men than women study civil construction?
- Have you had female professors? Do you feel there is a difference between male and female professors?
- Have you completed your professional internship and/or worked as an operator? Tell us about your experience.

Regarding the profile of the participants, they were required to be female students in the program who exhibited distinctive characteristics or significant achievements within the student body. These criteria included, for example, participation in teaching assistantships, student initiatives, the student council, or sports teams. This strategy helped identify students whose experiences and academic trajectories could provide a more enriching perspective on gender gaps and their specific challenges in this context. Table 1 presents a characterization of the female students interviewed.

Table 1. Characterization of the interviewees.

Number of interviewees	Age	Year of admission	Previous degree	Extracurricular activities
1	27	2020	Civil Engineering	Teaching Assistantships
2	23	2018	-	Teaching Assistantships
3	24	2019	-	Student initiatives
4	24	2018	-	Student initiatives
5	28	2015	Metallurgy	Teaching Assistantships
6	23	2019	-	Student Council
7	24	2019	-	Student initiatives
8	21	2021	-	Student Council
9	25	2020	Mathematics Education	Sports team
10	21	2022	-	Student Council

12. Interview analysis

The interviews were recorded after obtaining informed consent from the participants, which an external ethics committee approved. The researchers then transcribed and analyzed the data for coding.

The coding process began with analyzing interview excerpts using the live coding method. This approach allowed for the real-time labeling of text segments during data analysis (Saldaña, 2013). The coding involved highlighting excerpts from the interviews at the sentence level, facilitating the identification of key phrases relevant to the study.

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Subsequently, these excerpts were organized into categories and subcategories to establish a robust analytical structure (Namey et al., 2008); (Saldaña, 2021). The categories focused on more general and broad concepts, while the subcategories concentrated on more specific themes that emerged from these categories. This organization clarified the data and helped identify patterns and trends in the participants' experiences.

As a result of this coding process, a coding dictionary was developed, which included the category, subcategory, a clear definition of each, and examples of excerpts from the interviews, as illustrated in Table 2.

Table 2. Coding dictionary.

Category	Subcategory	Definition	Example
Factors influencing women to study civil construction	**Family support**	Family members' emotional and practical support encourages or discourages women from choosing careers traditionally dominated by men, such as construction.	"Because women are not encouraged to pursue these careers from an early age."
	Cultural stigma	Deep-rooted social prejudices that associate construction with a predominantly male field create emotional, psychological, and professional barriers to women's participation.	"We have always been told that construction is a man's environment and that we are unprepared for their humor."
Women Professors	**Teaching equity**	References to the difference in the number of male and female professors in teaching positions.	"There are very few female professors. I would love to see more because there are differences in how men and women teach."
	Welcoming environment	Creation of a more inclusive and familiar environment that fosters students' emotional well-being, facilitated by the presence of female professors.	"Female professors are more approachable, creating a friendlier and more familiar environment."
	Trust	The sense of security and closeness experienced by students when interacting with female professors facilitates communication and learning.	"I feel more comfortable asking questions because it creates a trusting environment, maybe because we are both women."
	Female role models	The presence of female professors as role models for students inspires them both professionally and personally.	"Having female professors is like having a role model, especially as a professional."
Industrial and Professional Practice	**Gender parity**	The equality in opportunities and representation between men and women in the workplace reflects the perception of significant	"I was the only woman out of 50 people. Unfortunately, this is common in construction."

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		differences in female representation, especially in traditionally male environments.	
	Inappropriate situations	Mentions of events that caused discomfort and/or distress due to comments, jokes, pranks, and/or experiences that were inappropriate, unpleasant, and/or upsetting.	"One of the bosses asked me uncomfortable and personal questions."
	Support	Assistance and backing from colleagues or supervisors at work, promoting the learning and well-being of women in the workplace.	"The workers looked after me and made sure to teach me."
Reason for Joining	**Personal interest**	References to the attraction, interest, or curiosity toward the construction field before entering it.	"I always liked it. I would think, 'How is a building constructed?' I liked seeing how construction improved people's lives."
	Family factor	Mentions of family influence in the choice of career.	"An uncle told me, 'Do you know about the construction career?' and that is when I started to get interested."
	Exposure to the sector	Mention experiences involving direct contact with the construction environment, reflecting exposure to the professional field.	"I went to a construction site in my last year of high school, and I liked it."
Suggestions for Enrollment and Retention of Female Students	**Communication channels**	Modernization and use of communication media to attract the attention of young women interested, using platforms popular among them.	"It would be good to modernize the communication channels because young people are using new social networks like TikTok."
	Professional role models	It highlights women professionals in the construction field as a source of motivation for current and prospective female students.	"Seeing professional women is very motivating for studying or continuing in the career."
	Inclusive promotion	Strategies to encourage women to study construction careers, showcasing practical examples and experiences in the sector and highlighting the role of women in the industry.	"I think vocational fairs could highlight the role of women in the industry more."
	Meeting spaces	Creation and maintenance of spaces where female students can share experiences, receive support, and participate in activities related to their construction career	"The meeting spaces at the university are good. I hope they continue and increase, with different focuses, whether talking, activities or simply hanging out and sharing experiences."

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Once the coding was completed, the researchers calculated the frequencies of each category and subcategory. Two types of frequencies were considered: the first corresponds to the total number of mentions regarding a specific topic, and the second reflects the number of respondents who mentioned each category or subcategory. This approach allows for identifying the topics' relevance and the degree of consensus among the participants. See Table 4.

13. Results

13.1 Review of articles

To understand the global studies, Table 3 presents the country where each study was conducted, the selected articles' titles, authors, year, method used, and sample.

Table 3. Summary of the methodology of the selected documents.

Country	Title	Authors	Year	Method	Sample
Nigeria	Barriers to attracting and retaining female construction graduates into academic careers in higher education institutions	Owolabi, J. D., Ogundipe, K. E., Ogunbayo, B. F., & Aigbavboa, C. O.	2023	Survey	300
Spain	Sex, age, work experience, and relatives in building engineering career development.	Infante-Perea, M., Navarro Astor, E., & Román-Onsalo, M.	2021	Survey	704 final-year university students from Technical Schools
United States	Recognizing differences in underrepresented civil engineering students' career satisfaction expectations and college experiences	Keku, D., Paige, F., Shealy, T., & Godwin, A.	2021	Survey	4,605 civil engineering students
United States	Gender and engineering identity among upper-division undergraduate students	Hamlet, L. C., Roy, A., Scalone, G., Lee, R., Poleacovschi, C., & Kaminsky, J.	2021	Survey	11 civil engineering and construction programs
Nigeria	An empirical investigation of the mentor-mentee relationship among female architects and female architectural students	Afolabi, A. O., & Akinola, A.	2021	Survey	84 female architects and students
South Africa	Female students' preparedness for a male-dominated workplace	Alves, S., & English, J.	2018	Survey	6 focus groups with 17 students each
Australia	Why Australian female high school students do not choose construction as a career: A qualitative investigation into value beliefs about the construction industry	Carnemolla, P., & Galea, N.	2021	Semi-structured interview	15 high school students
New Zealand	What influences women to study architectural, engineering, or construction (AEC) majors?	MacDonald, F., & Durdyev, S.	2021	Survey	30 architecture, engineering, and construction students

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14. Survey results

As the Methodology section mentions, Figure 3 presents the survey results conducted with civil construction students at USM. These results provide a comprehensive overview of the perceptions and experiences of female students regarding gender gaps.

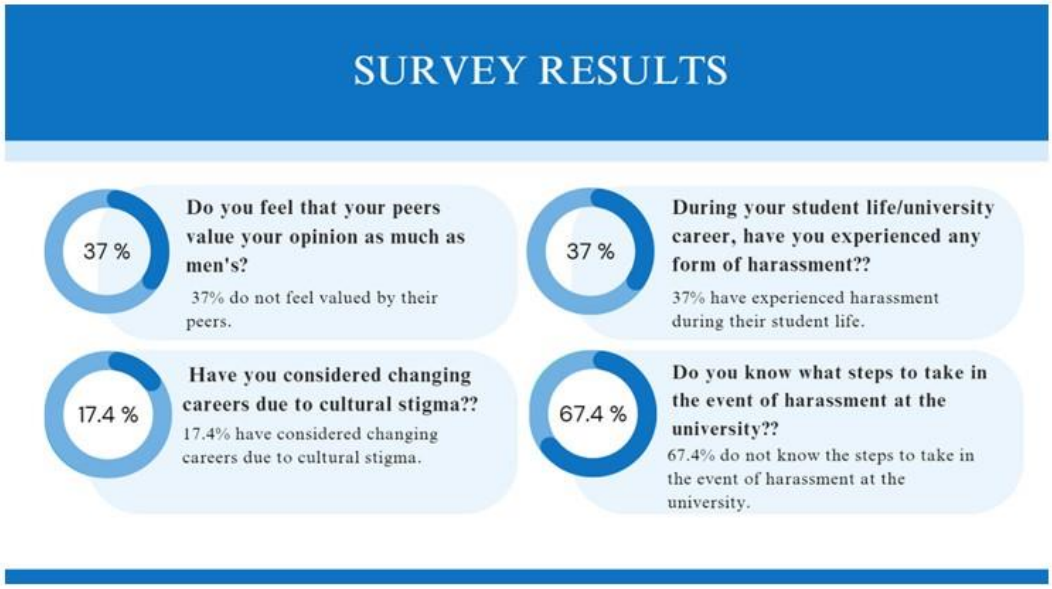

Figure 3. Survey Results.

In the final open-ended question, "What concerns do you see in your professional future?" participants expressed worries about recognizing their knowledge, job stability, and the limited opportunities for advancement, which often favor men. They also expressed concern about not being recognized as authority figures in a male-dominated environment and that their opinions are less valued than those of their male colleagues.

Fear of harassment and workplace inequality were common concerns among participants. One stated, "Working on-site causes me anxiety due to uncomfortable experiences I encountered during my internship." They also mentioned a lack of opportunities, wage disparity, and the impact of motherhood. One student wrote, "Issues related to pregnancy in construction often result in unjustified dismissals." However, some expressed confidence, highlighting women's progress in the sector.

15. Interview results

Table 4 presents the results obtained for each category and subcategory, including the frequency of mentions, which indicates how many times the interviewees addressed a specific topic, and the number of interviewees who referred to each topic.

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Table 4. Frequency of responses from interviews.

Category	Subcategory	N° of mentions (N° of interviewees)	Percentage value	
			mentions	Interviewees
Factors influencing women to study civil construction	Family support	7(6)	23%	60%
	Cultural stigma	23(10)	77%	100%
	Total	**30(10)**	**100%**	**100%**
Women Professors	Teaching equity	3(2)	9%	20%
	Welcoming environment	15(6)	44%	60%
	Trust	15(7)	44%	70%
	Female role models	1(1)	3%	10%
	Total	**34(8)**	**100%**	**80%**
Industrial and Professional Practice	Gender parity	9(6)	24%	60%
	Inappropriate situations	8(4)	22%	40%
	Support	20(6)	54%	60%
	Total	**37(9)**	**100%**	**90%**
Reason for Joining	Personal interest	8(6)	50%	60%
	Family factor	5(4)	31%	40%
	Exposure to the sector	3(3)	19%	30%
	Total	**16(8)**	**100%**	**80%**
Suggestions for Enrollment and Retention of Female Students	Communication channels	5(3)	14%	30%
	Professional role models	9(6)	24%	60%
	Inclusive promotion	13(9)	35%	90%
	Meeting spaces	10(7)	27%	70%
	Total	**37(10)**	**100%**	**100%**

The results highlight that 100% of the female interviews indicate that cultural stigma is one of the main factors influencing women's decision to study civil construction. Regarding the educator category, 60% of participants mentioned that female instructors created a more welcoming environment in their classes than their male counterparts. In terms of the category concerning their experiences during industrial and/or professional internships, the subcategory "support" stands out with 54% of mentions, as it was cited by 60% of the total interviewees. Finally, concerning suggestions to improve the enrollment and retention of female students in civil construction programs, the subcategories "inclusive promotion" and "meeting spaces" were identified as potential solutions by 90% and 70% of participants, respectively.

16. Discussion

The research aimed to identify and analyze the critical factors influencing women's low participation and retention in the civil construction field, both in educational and professional contexts.

The literature review suggests that the decision to study construction is significantly influenced by cultural stigmas and the perception that the industry is male-dominated (Carnemolla and Galea, 2021). This stigma, linking the field to masculinity, remains a significant barrier for women considering a career in construction. 17.4% of surveyed female students indicated they had considered switching majors due to this cultural stigma, confirming a disconnect between women and the profession. Additionally, 100% of interviewees emphasized that cultural stigma is one of the main factors deterring women from choosing civil construction as a field of study.

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Despite the cultural stigmas discouraging many women from entering the construction field, those who choose this career are driven by various factors. Family support, school guidance, and access to information about the field play a key role in their decision to pursue civil construction. In line with previous studies, the results show that personal interest, job opportunities, and salary expectations also influence the choice of this career (MacDonald and Durdyev, 2021). Interview results show that 60% of participants identified a personal interest in construction as their primary motivation. Additionally, 40% of interviewees mentioned that their motivation was linked to family influence, whether due to tradition or encouragement. These findings highlight that, despite the challenges and negative perceptions associated with the industry, women who choose this career are motivated by a combination of personal passion and family influence (Yan et al., 2024). This suggests that although cultural stigma persists, there are personal and close factors that counteract its impact.

On the other hand, the findings of this study support the idea that the presence of female professors is an important factor in the motivation and academic success of female students in male-dominated fields. According to Owolabi et al., (2023), one of the main obstacles to attracting and retaining female academics in engineering is gender discrimination and lack of support. The results of this study show that respondents perceive the presence of female professors as a significant factor in their empowerment and success in the field. Sixty percent of the interviewees mentioned that female professors created a more welcoming environment compared to male professors, making them feel more comfortable and motivated.

However, despite the clear need for female professors as role models, respondents noted that the presence of women in the field of construction is significantly low. This finding aligns with the results of Afolabi and Akinola, (2021), who found that the limited presence of female professors in disciplines such as engineering negatively affects students' perceptions of their ability to succeed in a field so dominated by men. The lack of female professors limits students' opportunities to build meaningful connections with female role models, which could impact their motivation and persistence in the field (Olushola and Akinola, 2021); (Moraba and Babatunde, 2020). In this regard, the importance of having female role models in higher education is emphasized to foster a more inclusive and supportive environment for female students. These findings suggest that increasing female representation in the faculty could significantly enhance the educational experience of female students in construction-related programs.

Another key issue identified in the surveys was harassment. The surveys revealed that 37% of female students reported experiencing harassment during their training, highlighting the presence of a hostile environment that can impact their well-being and retention. Meanwhile, 67% did not know how to proceed in such situations. Additionally, 40% of the interviewees mentioned experiencing inappropriate situations during their internships. However, it is important to note that despite these challenges, 60% of the interviewees mentioned feeling supported in their workplaces during their internships. This perception of support is crucial, as it helps create a more inclusive and conducive environment for professional development. This suggests that although women face challenges, they can also find solidarity and camaraderie in their work environments. Such support can play a vital role in mitigating the negative effects of harassment and discrimination, helping female students feel valued and motivated to remain in the sector. Fostering a culture of support and respect in the workplace not only benefits women in construction but can also improve overall team productivity and cohesion. Therefore, it is essential that organizations implement policies that not only address harassment but also actively promote a supportive environment for all women workers.

Additionally, this study highlights elements that do not always receive sufficient attention in the literature, such as the presence of professional role models during career outreach, which can positively influence women's decisions to enter the construction field (Keku, 2021). Furthermore, the importance of having meeting spaces for women within the university is underscored. The literature has already documented that social support is an effective strategy for addressing gender bias (Lekchiri ana Kamm, 2020). The interviewees indicated that these spaces not only provide emotional support but also allow them to share experiences and build support networks that strengthen their retention in the program.

17. Conclusions

This research, grounded in a literature review and the analysis of surveys and interviews, highlights the complexity of the factors affecting the participation and retention of women in the civil construction field. While cultural stigmas pose a significant barrier, personal interest and familial influence motivate women to overcome these limitations. The results reveal that, despite the challenges, a significant percentage of the interviewees (60%) reported feeling supported during their work experiences, suggesting that the industry's culture may be beginning to shift towards a more inclusive and supportive environment.

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This support is crucial, as it enhances female workers' satisfaction and could help increase the retention of women in the sector. Increasing female representation among faculty and within the professional realm can be an essential step toward reinforcing this cultural change.

Furthermore, establishing support networks and meeting spaces specifically for women within the university is proposed as an effective strategy to enhance female students' retention and counteract stigmas' impact.

Ultimately, the success of future initiatives aimed at increasing female participation in civil construction will depend on a combination of efforts that encompass cultural, educational, and organizational changes. As the industry moves towards a more diverse and inclusive landscape, fostering an environment where women enter, remain, and thrive in their professional careers will be essential.

Among the limitations of this research are the need for more information and restricted access to relevant documents on the topic. Additionally, the study focused exclusively on one university and a specific program, omitting students' perspectives from other institutions and related fields within the construction sector. Future research should consider comparing gender gaps across more universities in Chile and expanding the study to other engineering and construction-related programs. Such an approach would allow for a broader debate and a deeper understanding of gender dynamics within the sector.

Additionally, the study focused exclusively on one university and a specific program, omitting students' perspectives from other institutions and related fields within the construction sector. Future research should consider comparing gender gaps across more universities in Chile and expanding the study to other engineering and construction-related programs.

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19. Declaration of AI-Assisted Tools in Manuscript Preparation

In this work, the “ChatGPT 4” chatbot was used to improve the texts' spelling, grammar, syntax, and writing. It is important to note that the use of this tool was restricted solely to these technical aspects without affecting the content, analysis, interpretation of the data, or the conclusions presented. All ideas, arguments, and results presented here are the independent efforts of the authors.

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21. References

Afolabi, A. O.; Akinola, A. (2021). An empirical investigation of the mentor-mentee relationship among female architects and female architectural students. International Journal of Emerging Technologies in Learning, 16(13), 168. https://doi.org/10.3991/ijet.v16i13.21971

Alves, S.; English, J. (2018). Female students’ preparedness for a male-dominated workplace. Journal of Engineering, Design and Technology, 16(4), 581-595. https://doi.org/10.1108/jedt-03-2018-0039

Amaratunga, D.; Haigh, R.; Lee, A.; Shanmugam, M.; Elvitigala, G. (2006). Construction Industry and Women: A Review of the Barriers. In: 3rd International SCRI Research Symposium, Delft University, Netherlands. Salford, University of Salford.

ISSN: 0718-5073

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Nº3 2024
DOI: 10.7764/RIC.00123.21

Barreto, U.; Pellicer, E.; Carrión, A.; Torres-Machí, C. (2017). "Barriers to the professional development of qualified women in the Peruvian construction industry." Journal of Professional Issues in Engineering Education and Practice, volume 143, issue 4, http://dx.doi.org/10.1061/(ASCE)EI.1943-5541.0000331

Berlien, K.; Varela, P.; Robayo, C. (2016). Realidad nacional en formación y promoción de mujeres científicas en ciencia, tecnología, ingeniería y matemáticas. Santiago, Chile: CONICYT. https://observa.minciencia.gob.cl/estudios/genero-y-stem-2016:-realidad-nacional-enformacion-y-promocion-demujeres-cientificas-en-ciencia-tecnologia--ingenieria-ymatematicas

Brantt, M. L.; Soto, P.; Zuchel, L. (2024). Desafíos de género en STEM: Contribuciones filosóficas para una justicia epistémica. trans/form/ação: Revista de Filosofia da Unesp, 47(2), e02400190. https://doi.org/10.1590/0101-3173.2024.v47.n2.e02400190

Cámara Chilena de la Construcción (CChC). (2022). Caracterización de mujeres en la construcción. Informes sobre participación de mujeres en el rubro de la construcción. https://www.cdt.cl/camara-chilena-de-la-construccion-presento-estudio-sobre-la-participacion-de-las-mujeres-en-construccion/

Canales, A.; Cortez, M. I.; Sáez, M.; Vera, A. (2022). Brechas de género en carreras STEM. En: Centro de Políticas Públicas UC (ed.), Propuestas para Chile. Concurso de Políticas Públicas 2021 (pp. 115-150). Santiago: Pontificia Universidad Católica de Chile. https://www.mat.uc.cl/archivos/mujeres-y-matematica/brechas-de-genero-en-stem.pdf

Cao, J.; Liu, C.; Wu, G.; Zhao, X.; Jiang, Z. (2020). Work–family conflict and job outcomes for construction professionals: The mediating role of affective organizational commitment. International Journal of Environmental Research and Public Health, 17(4), 1443. https://doi.org/10.3390/ijerph17041443

Carnemolla, P.; Galea, N. (2021). Why Australian female high school students do not choose construction as a career: A qualitative investigation into value beliefs about the construction industry. Journal of Engineering Education, 110(4), 819-839. https://doi.org/10.1002/jee.20428

De Granda-Orive, J. I.; Alonso-Arroyo, A.; García-Río, F.; Solano-Reina, S.; Jiménez-Ruiz, C. A.; Aleixandre-Benavent, R. (2013). Ciertas ventajas de Scopus sobre Web of Science en un análisis bibliométrico sobre tabaquismo. Revista Española de Documentación Científica, 36(2), e011. https://doi.org/10.3989/redc.2013.2.941

Del Río, M. F.; Strasser, K.; Susperreguy, M. I. (2016). ¿Son las habilidades matemáticas un asunto de género?: Los estereotipos de género acerca de las matemáticas en niños y niñas de Kínder, sus familias y educadoras. Calidad en la Educación, 45, 20-53. https://doi.org/10.4067/s0718-45652016000200002

Demre. (2024). Postulaciones a la educación superior: mujeres seleccionadas en carreras de ciencia y tecnología (STEM) aumentan 16,8%. Demre. https://demre.cl/noticias/2024-01-16-mujeres-seleccionadas-stem-aumentan-16-porciento

Gerencia de Estudios Cámara Chilena de la Construcción. (2022). Informe MACh 60, Macroeconomía y Construcción. Cámara Chilena de la Construcción. https://cchc.cl/uploads/archivos/archivos/Informe-MACh-60.pdf

Ghanbaripour, A. N.; Tumpa, R. J.; Sunindijo, R. Y.; Zhang, W.; Yousefian, P.; Camozzi, R. N.; Hon, C.; Talebian, N.; Liu, T.; Hemmati, M. (2023). Retention over attraction: A review of women's experiences in the Australian construction industry; challenges and solutions. Buildings, 13(2), Article 2490. https://doi.org/10.3390/buildings13020490

Godwin, A.; Potvin, G. (2017). Pushing and pulling Sara: A case study of the contrasting influences of high school and university experiences on engineering agency, identity, and participation. Journal of Research in Science Teaching, 54(4), 439-462. https://doi.org/10.1002/tea.21372

Hamlet, L. C.; Roy, A.; Scalone, G.; Lee, R.; Poleacovschi, C.; Kaminsky, J. (2021). Gender and engineering identity among upper-division undergraduate students. Journal of Management in Engineering, 37(2). https://doi.org/10.1061/(asce)me.1943-5479.0000876

Heydari, M. H.; Shojaei, A.; Naderi, H.; Iorio, J. (2024). Paving the way for progress: A systematic literature review on diversity, equity, and inclusion in the AEC industry. Journal of Management in Engineering, 40(3), 03124001. https://doi.org/10.1061/JMENEA.MEENG-5886

Infante-Perea, M.; Navarro Astor, E.; Román-Onsalo, M. (2021). Sex, age, work experience, and relatives in building engineering career development. Journal of Management in Engineering, 37(5), 1-15. https://doi.org/10.1061/(ASCE)ME.1943-5479.0000935

Keku, D.; Paige, F.; Shealy, T.; Godwin, A. (2021). Recognizing differences in underrepresented civil engineering students' career satisfaction expectations and college experiences. Journal of Management in Engineering, 37(4). https://doi.org/10.1061/(ASCE)ME.1943-5479.0000902

Lekchiri, S.; Kamm, J. D. (2020). Navigating barriers faced by women in leadership positions in the US construction industry: A retrospective on women's continued struggle in a male-dominated industry. European Journal of Training and Development, 44(6/7), 575-594. https://doi.org/10.1108/EJTD-04-2020-0068

León, N. (2022). Proyecciones para la construcción. Informe de Proyección Estudios y Políticas Públicas CChC. https://www.ccs.cl/wp-content/uploads/2023/11/231123-CChC.pdf

MacDonald, F.; Durdyev, S. (2021). What influences women to study architectural, engineering, or construction (AEC) majors? Journal of Civil Engineering Education, 147(2). https://doi.org/10.1061/(ASCE)EI.2643-9115.0000035

ISSN: 0718-5073

Vol. 39
Nº3 2024
DOI: 10.7764/RIC.00123.21

Madikizela, K.; Haupt, T. (2010). Influences on women's choices of careers in construction: A South African study. Australasian Journal of Construction Economics and Building, 10(1/2), 1-15. https://doi.org/10.5130/AJCEB.v10i1-2.1582

Menches, C. L.; Abraham, D. M. (2007). Women in construction—Tapping the untapped resources to meet future demands. Journal of Construction Engineering and Management, 133(9), 701–707. https://doi.org/10.1061/(ASCE)0733-9364(2007)133:9(701)

Mi Futuro. (2023). Buscador de estadísticas por carrera: construcción civil. Mi Futuro. https://www.mifuturo.cl/buscador-de-estadisticas-por-carrera/. Acceso 12 de octubre 2024.

Ministerio de Economía, Fomento y Turismo. (2023). Quinto reporte de indicadores de género en las empresas en Chile 2023. Ministerio de Economía, Fomento y Turismo, Gobierno de Chile. Recuperado de https://www.economia.gob.cl/wp-content/uploads/2024/03/quinto-reporte-de-indicadores-de-genero-en-las-empresas-en-chile-2023.pdf

Ministerio de la Mujer y la Equidad de Género (MinMujeryEG). (2018). Más mujeres más ciencia. Ministerio de la Mujer y la Equidad de Género. https://minmujeryeg.gob.cl/?page_id=4080

Ministry of Business, Innovation and Employment. (2023). Workforce dynamics and demographics. https://www.mbie.govt.nz/building-and-energy/building/building-system-insights-programme/sector-trends-reporting/building-and-construction-sector-trends-annual-report/2023/2023-3

Moraba, Y.; Babatunde, O. (2020). Graduating female students' long-term career decisions and underrepresentation of women in South Africa's construction industry. En Aigbavboa, C.; Thwala, W. (Eds.) (2020) The construction industry in the fourth industrial revolution. CIDB 2019 (pp. 158-167). Springer, Cham. https://doi.org/10.1007/978-3-030-26528-1_16

Namey, E.; Guest, G.; Thairu, L.; Johnson, L. (2008). Data reduction techniques for large qualitative data sets. En Handbook for team-based qualitative research (Vol. 2, No. 1, pp. 137-161).

National Academies of Sciences, Engineering, and Medicine. (2018). Sexual harassment of women: Climate, culture, and consequences in academic sciences, engineering, and medicine. The National Academies Press. https://doi.org/10.17226/24994

Olushola, A.; Akinola, A. (2021). An empirical investigation of the mentor-mentee relationship among female architects and female architectural students. International Journal of Emerging Technologies in Learning, 16(13), 168. https://doi.org/10.3991/ijet.v16i13.21971

Owolabi, J. D.; Ogundipe, K. E.; Ogunbayo, B. F.; Aigbavboa, C. O. (2023). Barriers to attracting and retaining female construction graduates into academic careers in higher education institutions. Buildings, 13(10), 2673. https://doi.org/10.3390/buildings13102673

Page, M. J.; McKenzie, J. E.; Bossuyt, P. M.; Boutron, I.; Hoffmann, T. C.; Mulrow, C. D.; Shamseer, L.; Tetzlaff, J. M.; Akl, E. A.; Brennan, S. E.; Chou, R.; Glanville, J.; Grimshaw, J. M.; Hróbjartsson, A.; Lalu, M. M.; Li, T.; Loder, E. W.; Mayo-Wilson, E.; McDonald, S.; McGuinness, L. A.; Stewart L. A.; Thomas, J.; Tricco, A. C.; Welch, V. A. (2021). The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. BMJ, n71. https://doi.org/10.1136/bmj.n71

Saldaña, J. (2013). Coding manual. In The coding manual for qualitative researchers (1ra ed.). SAGE.

Saldaña, J. (2021). The coding manual for qualitative researchers (2da ed.). SAGE.

Servicio de Información de Educación Superior (SiEs). (2024). Brechas de género en educación superior 2023. Mi Futuro. https://www.mifuturo.cl/brechas-de-genero-en-educacion-superior/. Acceso 12 de octubre 2024.

Sevilla, M. P.; Bordón, P.; Ramirez-Espinoza, F. (2023). Reinforcing the STEM pipeline in vocational-technical high schools: The effect of female teachers. Economics of Education Review, 95, 102428. https://doi.org/10.1016/j.econedurev.2023.102428

Simonsen, E. (2020). ¿Por qué hay baja participación de mujeres en carreras matemáticas y de ciencias? Portal Noticias Universidad de Chile. https://uchile.cl/u166324

Stratton, S. J. (2021). Population research: Convenience sampling strategies. Prehospital and Disaster Medicine, 36(4), 373-374. https://doi.org/10.1017/s1049023x21000649

Yan, D.; Wang, C. C.; Sunindijo, R. Y. (2024). Framework for promoting women's career development across career stages in the construction industry. Journal of Construction Engineering and Management, 150(7), 04024062. https://doi.org/10.1061/JCEMD4.COENG-14644

Zhang, R. P.; Holdsworth, S.; Turner, M.; Andamon, M. M. (2021). Does gender really matter? A closer look at early career women in construction. Construction Management and Economics, 39(8), 669–686. https://doi.org/10.1080/01446193.2021.1948087

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